ERDC TN-DOER-T4
December 2001

Special PIANC Session on Environmental Dredging

PURPOSE: This technical note summarizes the presentations and lessons learned discussions from the special PIANC (Permanent International Association of Navigation Congresses) session on environmental dredging on June 26, 2001, at the 21st Meeting of the Western Dredging Association (WEDA) in Houston, Texas.

BACKGROUND: The Innovative Dredging Technology Focus Area (IT) of the Dredging Operations and Environmental Research (DOER) Program emphasizes identifying and evaluating innovations in dredging operations, processes, or equipment and techniques developed by dredging and dredging-related industries worldwide. As part of this effort, DOER IT uses workshops and professional meetings to bring together key individuals from academia, industry, and government to exchange information and innovations on state-of-the-art technologies for dredging and dredged material management. On June 26, 2001, the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi, and WEDA sponsored a special PIANC session, "Environmental Dredging," during the 21st Meeting of WEDA in Houston, Texas. The emphasis of the session was on identifying key components of environmental dredging and defining the present capabilities of the dredging industry to meet certain goals of environmental dredging projects.

INTRODUCTION: Approximately 225 dredging professionals registered and attended the Western Dredging Association 21st Annual Technical Conference, Texas A&M 33rd Dredging Seminar, and Special PIANC Session on Environmental Dredging. Seventy-five people attended the special session on environmental dredging that was held on the last day of the WEDA meeting. The session attracted broad representation from the dredging industry, private consulting, environmental regulatory agencies, and academia. The purpose of the workshop was to conduct a critical review of environmental dredging technologies presently being implemented in cleanup projects across the nation. The agenda for the Session is given in Appendix I.

Five speakers (Photo 1) from private industry and government gave key presentations in Panel A of the session. Copies of their presentations are available in the electronic version of this note at *www.wes.army.mil/el/dot/doer/*.

PANEL A: PRESENTATIONS

Defining the Effectiveness of Environmental Dredging - Paul Doody, Blasland, Bouck, and Lee, Inc. Most of the environmental dredging projects completed to date have involved low volumes (less than 50,000 cu yd [38,000 cu m]). Because we are at the threshold of evaluating remedial management options for sites typically involving 100,000 to 1,000,000 plus cubic yards [76,500 to 765,000 cu m] of material, the effectiveness of environmental dredging has become even more important. Experience from completed projects demonstrates certain limitations in the effectiveness of environmental dredging to reduce risks, which typically is the primary

Photo 1. PIANC Panel on Environmental Dredging (Left to right: John Henningson, Norman Francingues (Moderator), Mike Crystal, Phil Spadaro, Ancil Taylor, Bob Paulson (Paul Doody not shown))

objective of environmental dredging. The important "risk-based" factors that determine the effectiveness of environmental dredging differ substantially from many of the important effectiveness factors associated with navigational dredging. As such, environmental and navigation dredging risks were contrasted, while "Dredging Effectiveness" and how to interpret it in the context of several key issues and important measurements were defined. Actual data from completed projects were used to help illustrate the central themes of the presentation. Some of the key observations include the following:

- Most experience to date is limited to relatively small sites with small databases.
- Dredging has limitations in reducing surface layer contaminant concentrations.
- Resuspended solids can be controlled; however, elevated concentrations are seen in the water column during the time of dredging.
- Effects of dredging on fish tissue concentrations are not quantifiable.
- Environmental dredging is distinctively different from navigation dredging.

Dredging for Environmental Remediation - Ancil Taylor, Bean Environmental. A new environmental dredge was deployed at New Bedford Harbor, Massachusetts, as part of the Superfund Remediation project. The dredging technology selected for field study was the Horizontal Profiling Grab (HPG) dredge designed and operated by Bean Environmental. The HPG was selected from more than sixty dredge technologies surveyed around the world for application at New Bedford Harbor. The key performance measures evaluated in the test were sediment removal accuracy (within 4 in. [102 mm]), transportation and disposal efficiency (70 percent solids by volume), polychlorinated biphenyl (PCB) removal effectiveness (97 percent removal), air and water quality impacts by the dredging operation (limited impacts), and dredged material production (95 to120 cu yd [73 to 92 cu m] per hour).

Fox River Environmental Dredging Project. As a result of historical discharges to the Fox River system, bottom sediments in the lower river are impacted by PCBs and other pollutants. A hot spot, Sediment Management Unit (SMU) 56/57, was selected as the demonstration project that was undertaken in 1999 by the Wisconsin Department of Natural Resources (WIDNR) and the Fox River Group (FRG) of seven named Principal Responsible Parties (PRPs). The purpose of the pilot study was to provide important information regarding large-scale sediment restoration projects in the lower Fox River. The FRG included the Fort James Corporation, located on the river at Green Bay, which has had a keen interest in the selection of appropriate, technically sound, and cost-effective remediation and restoration actions to improve sediment quality in the lower portion of the river. The following presentations were coordinated to provide various perspectives regarding the demonstration of environmental dredging in the Fox River.

- **Regulator's Perspective - Bob Paulson, Wisconsin Department of Natural Resources:** In February of CY 2000, WIDNR requested assistance from the U.S. Environmental Protection Agency (USEPA) to complete Fox River dredging activities, which had begun with the 1999 dredging demonstration. USEPA duly noted the importance of successfully completing such a regionally and nationally significant dredging project. In order to accomplish this, it was necessary to negotiate an Administrative Order on Consent (AOC) with the Fort James Corporation, a private industrial owner adjacent to the Fox River at Green Bay. Negotiations also involved WIDNR and representation by local Indian tribes. The lessons learned from the demonstration project and experienced project managers would provide the necessary information to make dredging a viable alternative for current and future remedial work on the Fox River and completion of dredging activities in the CY 2000 construction season. Expedited negotiations, planning, and design were paramount for project success. Given the controversy surrounding previous dredging activities, sediment cleanup goals, and environmental, health, and cost benefits, it was absolutely necessary to select cleanup objectives that could be completed in a shortened construction season. Implementing and completing the project in a single construction season required constant oversight and monitoring, ensuring project milestones and target dates were achieved. This effort resulted in coordination of multiple agencies and contractors to conduct monitoring, confirmation sampling, public meetings, site meetings, interviews, confirmation of cleanup objectives, transportation, and disposal. The following lessons were learned during this pilot dredging project:
  - It was demonstrated to the Lower Fox River Valley Community that dredging would not result in "wide-scale community disruption."
  - Over 2,000 lb [907 kg] of PCBs were permanently removed from the river at SMU 56/57 and 112 lb [51 kg] at SMU N.
  - Sediments could be disposed in local landfills in compliance with regulatory permits.
  - Monitoring of the pilot study area showed minimum losses.
  - Objectives of the pilot dredging project were achieved.
- **Design and Quality Assurance, The Design Engineer's Perspective - John Henningson, Hart Crowser:** For a variety of reasons, the first attempt at dredging in SMU 56/57 did not meet the expectations of all participants and was unable to attain demonstration dredging goals. The dredging goal was consistent with the 1997 Agreement with the FRG to attain a specific target elevation based on in-place sediment data with a cutoff of 1 ppm. Fort James independently elected to redesign and complete the demonstration project as a full-scale

removal. Fort James retained Hart Crowser, Inc., to help negotiate the technical terms of a new agreement with USEPA and WIDNR and to reengineer the dredging and disposal plan. Because capacity at the only existing local disposal site was limited, the project relied on selecting a dredge prism that would achieve cleanup goals while limiting the removal to 50,000 cu yd [38,000 cu m]. Cleanup levels were set at 1 part per million (ppm) as the level for no further action, and 10 ppm would trigger a requirement for 6 in. [152 mm] of clean sand cover. The following important factors were learned from the demonstration project:

- Need to use experienced operators to assure accurate positioning and maximize solids production.
- Requirements for refinement of the dewatering system.
- Need for adequate redundancy of equipment to limit downtime.

Hart Crowser, Inc., also was responsible for the quality assurance of the confirmatory sampling program after completion of dredging. Test results show that the proposed dredging plan was viable. PCB concentrations in surface sediments were below 10 ppm after dredging. The success of this project, owed in part to cooperative efforts of WIDNR, USEPA, and Fort James Corporation, working with the contractor, showed that environmental dredging could be an important component of future solutions to PCB contamination in the Fox River.

- **Contractor Implementation - Mike Crystal, Sevenson Environmental Services:** Sevenson Environmental was selected as the dredging contractor to implement the approved restoration and remediation plan. Sevenson brought a project site team with experienced operators from recent, relevant PCB removal projects on the St. Lawrence River, River Raisin, Niagara River, and Lake Champlain in New York. Sevenson Environmental Services proposed several refinements to the project:
  - Mechanical dewatering train that avoided the downtime associated with rehandling out of the passive lagoons.
  - Wastewater treatment plant sized to handle low dredged solids (if necessary).
  - Use of multiple dredges to maintain schedule and conduct debris removal ahead of and in conjunction with the dredging operation.
  - Improved dredge slurry pipeline management plan to accommodate the local shipping schedule. These factors combined to facilitate successful implementation of the dredging plan.

PANEL B: LESSONS LEARNED: At the conclusion of the Panel A presentations, the technical review panel was convened as Panel B of the session to identify lessons learned and to ask questions about how to choose an environmental dredging technology. The Co-Chair, Norman Francingues, made a short presentation (Appendix II) on environmental dredging components, site survey and characterization, dredging, transport, placement and disposal, and management.

If a decision is made to dredge, one needs to recognize that risk does not go away. It changes from one type of risk to another. Each step in an environmental dredging process has a risk component. Hopefully, when the project is completed, the total risk will be reduced to an acceptable level. There is a cost associated with each of the components, and there is also a risk associated with each one of these parts. So, when we define environmental dredging, the lesson that has been learned is that we should not overlook any of these components.

Unfortunately, due to the limitations of time, the focus of Panel B was limited to lessons learned about the environmental dredging component because this component involves resuspension that is raised as an environmental issue by most everyone when they ask about the process of dredging.

A presumption was made for the sake of the Panel B discussions that there was already a decision to dredge contaminated sediments using an appropriate risk-based framework. As the organizers of the session asked a number of key questions, each question was directed to a panel member for a response and then the audience was asked to provide comments.

SUMMARY OF QUESTIONS AND RESPONSES

Session Moderator: Should environmental dredging contracts be performance based or tightly specified? Or, does this matter?

Panel Answer: One panel member concluded that contracts definitely need to be performance based. The successful contracts have been the ones where the client has articulated the project goal in a sufficient way that contractors can respond to the real requirement to accomplish the cleanup. A number of cases were identified where the client has done his own research regarding what specific technology he might want to use and all but specified in the contract the use of a particular piece of equipment on the project rather than a goal to accomplish the cleanup. It was inferred that a performance-based contract helps problem owners out of that paradigm. There are engineering firms who have the resources to address critical projects. These are the companies that the owners should use to help them develop the performance-based contracts. The dredging contractors have been dealing with these engineering firms for a long time, and they know who they are and what they can do. The engineering firms know the market, they know who is going to respond to the request for proposal (RFP) or invitation for bid (IFB), and they know who is not going to be able to accomplish the work. It was suggested that owners should pursue the use of performance-based contracts.

Audience Response: A member from the audience asked about the need to avoid focusing on a particular piece of equipment. It was observed that there is a constant battle with regulatory agencies that view equipment choice as paramount. Then the owners and their consulting firms have to implement a long, drawn-out process of explaining each time the problems we experience with the lack of a competitive market, i.e., using sole source type contracting. If the contractor, who has propriety on a piece of equipment, is unavailable to do the job, then who can do the work becomes a pressing discussion item. With so much attention on the whistles and bells or niftiest new kinds of equipment, the dilemma may become how to avoid falling into the sole-source trap and how to get the desired level of competition.

Panel Response: To answer the audience questions, one panel member suggested that you needed to take a look at the history of such projects. You take the demonstration of the projects, the difference between a performance-based contract and those that have been tightly specified on a single or sole-source piece of equipment. Dredging contractors understand the market. They also know who the players are out there. The panel member suggested that on every tightly specified contract RFP, the responsible dredging contractors will avoid bidding on that particular contract. If the owner says, "I want you to use this particular type of dredge, to swing it so fast, to drop the

bucket so fast, and this is the bucket I want you to use," the responsible dredging contractors will avoid that job. So, you will normally get the services of the local mom and pop organization that is more than willing to rent bodies to operate a particular piece of dredge. Unfortunately, the small, inexperienced contractors do not understand the complexities of dealing with a sensitive environmental dredging contract. The panel member concluded his remarks with "just take the history."

Session Moderator: So is this an education process?

Panel Response: Environmental dredging is such a changing field that the regulatory staffs who deal with a number of different kinds of partners must be educated by the engineering firms and dredging contractors. So, yes, the answer to the moderator's question is that this is truly an education process.

Audience Response: One participant went so far as to advise that the panel members temper their comments to qualify the circumstances where design-and-build type contracting may be appropriate. The example of projects like the Fox River pilot study that had to be completed within 90 days was cited as one that involved just digging and hauling the material to a landfill. However, the example of a remediation project that needed a confined disposal facility (CDF) requiring a formal design for the CDF would not be very compatible with the fast-track, design-construct process. So, the audience member cautioned the panel and others about obtaining the services of design-and-build firms by just using a performance-based contract that can present significant difficulty and problems for the more technically complex and challenging projects.

Session Moderator: Can the dredging industry meet strict excavation goals based on mass removal and/or residual concentration at the end point of excavation?

Panel Response: Clearly most of the projects have been designed to dredge to a target depth based on the concentration at some depth. And then after the fact, the question is Can you dig to or can you meet the residual concentration goals? It is very difficult to remove the last gram or a few centimeters on the surface that is highly mobile material. So, as far as defining success, one needs to know where you are starting from in terms of what you use to evaluate the dredging contractor's performance. The specification needs to be tied to a target elevation as an end point as opposed to some final superficial material concentration. The fact is clear that anybody who is going to bid the contract for a certain amount of money per subsequent number of passes needed will get paid for each one of those passes. The panel member did not think this was a very practical way to do the job and suggested that we needed to come to grips with this whole idea of residue on the surface because it is hard to define and is mobile. Several fishery studies have shown that there may be a timeline where there are higher concentrations of contaminants immediately after the dredging operation before the concentrations begin to decrease. He concluded that one should have good physical and chemical characterization of the superficial material before starting to dredge. Then the result would be that you are not dealing with superficial material after the fact and confounding the result by not knowing the baseline conditions of the superficial material.

Another observation was that there is no success during any remedial dredging if only the residual surface material is targeted unless there is good source control. It is impossible to get that last little bit until you've taken care of the sources. So, the rhetorical question asked by the panel member

was Can a contractor meet target goals based on both mass removal and concentration? He answered it "absolutely yes" and alluded to being better able to do so with the completion of each new project. But, in terms of the physical plan of excavating to a certain depth, he emphasized the need to deal with the residual question and the origin of the final layer of material.

Session Moderator: Does dredge operator performance play a significant role in meeting performance criteria for environmental dredging projects? If so, is special operator training required for these types of projects?

Panel Response: The panel unanimously answered yes for obvious reasons. One, it is critical to use competent people because your project result is only as good as your weakest laborer. As an example of one dredging contractor's commitment to using qualified operators on the Fox River job, the RFP for the job specifically stated that during the qualifying interview they would also interview the dredge operator. One of the four vendors did not agree to this requirement and was unable to provide a creditable dredge operator. So, this contractor was excluded from bidding on the project for that reason even though the firm furnished an attractive bid package.

Session Moderator: Along the lines of answering that question, is some special training needed for sensitive type dredging projects? For example, is operator certification desired and are there places for this type of training? Are there schools or other means of dredge operator training?

Panel Response: The response was that in addition to having trained operators, there was a need to demonstrate the means to train the dredge operators. One panel member stated that they were doing over one billion dollars worth of dredging around the world. So, they maintained facilities and simulators to train their operators to accomplish exactly what was needed and expected of them based on what they envisioned would be encountered on a particular project. He stated that "you must put the operators in conditions that are similar to those anticipated and see how they perform. Then you pick the best qualified from that group to report to the jobsite." All of the panel members concluded that training is extremely important and should not be underestimated.

Session Moderator: So you actually prequalify the operators before they go on the jobsite? Can they also do some OJT, on-the-job training? How about new operators and what type of supervision do they receive? Are they being mentored while on the job?

Panel Response: The key response was that there would not be any OJT on a sensitive project and especially not on an environmental dredging project.

Session Moderator: I guess maybe that this is a lesson learned, isn't it? We need to define (specify) in our dredging contracts the level of operator training needed for environmental dredging projects.

Panel Response: A comment was made to the effect that dredging contractors are not going to put a brother-in-law who operates a backhoe part time out there on the dredge.

One panel member added that during the operator interviews, each operator was questioned extensively. He was asked questions such as "How are you going to deal with a certain situation?" Although each operator gave different answers, it was evident from the answers how much

experience and training the operators had by the way they thought about their answer or solution. Without experience and training the operators wouldn't have been able to answer the questions satisfactorily.

Session Moderator: We find in our navigation projects, as well as the environmental cleanup projects, that we require highly skilled operators. We also find that sometimes there is a difference in production rates between daytime crews and nighttime crews. Staffing on different shifts and their level of expertise reflect on the performance of the dredging operation. So, you can design all of the elaborate plans, with all of the precision and accuracy; but, in most cases, it all comes down to the dredge operator and his ability to control everything that is going on during his shift.

Finally, I asked this question about operator training because I think it is important that we understand what we know and what we don't know about how we train dredge operators. One of the most important things that I have learned over the last couple of days during the WEDA meeting is that there are places to send operators for specialized training not only here in the U.S. but also overseas. Places like Texas A&M have dredging simulators. So, I think we need to examine further our dredging contract specifications to properly specify the technical qualifications and skills needed for personnel who do environmental dredging jobs.

Session Moderator: What are the appropriate economic measures of environmental dredging?

Panel Response: The response by a panel member was that this was a tough question and there was not a silver bullet answer. He offered that the owner and engineer try to go through a number of iterations to determine what makes sense early in the project. Many times the client is looking at cost of a CDF on his own property; if he were to build this site it needs to accommodate a certain percentage or a certain absolute value of overdredging material. He needs to determine what it is worth to him to minimize the size and the cost of that CDF and to compare that against the costs of delivering the 2- to 3-in. [50- to 76-mm] type of dredging precision.

It was also pointed out that the technologies presented by the contractors, Sevenson and Bean, may not always be economically feasible. Dredging costs vary around the nation from a low of 50-75¢ per cubic yard to as much as $85 per cubic yard. The goal is purely to provide the best value to the owner. The economics have to make sense to the owner. What may make sense to dredging operators may not make any sense in the end to the owner. The result of the discussion was that iteration should be part of the process of getting the best value for the job.

Session Moderator: I think there is a subpart to this question. That is, I would ask the panel to comment on incentives versus benefits in terms of defining economic measures of an environmental dredging project.

Panel Response: Recently, a client had a situation where he had approximately 33,000 to 35,000 cu yd [25,000 to 27,000 cu m] of contaminated sediment in the area that he was trying to clean up. He built a CDF on his site to contain this material at an estimated cost of around $150 per cubic yard. The client specified a clause in the dredging contract that said, "I want this quantity removed to a certain line (elevation) and if you remove any material below this line, you pay me $150 per cubic yard." In effect, he was liquidating his damages back to the contractor that if he

removed extra material, the contractor owed the owner the cost of containing the excess material on site. If that was, in fact, the owner's cost for containment, then that is the way it should have been handled. The incentive side of it was that the owner also specified in the contract a tolerance of about a foot. And if the dredging contractor left any material within that tolerance (i.e., the achieved grade that he left material in) then the owner paid the dredging contractor $15 per cubic yard for every cubic yard that was left in that 1-ft [0.3-m] tolerance. So those are financial-based penalty incentives that will help one achieve the level of performance that an owner is trying to achieve with this type of contract.

Session Moderator: That kind of project illustrates real out-of-box thinking of what can be done with incentives in contracts. So, we know that we can incorporate incentives in our contracts. We also know that we can incorporate liquidated damages as well. We have identified some excellent experiences (lessons learned) with this type of contracting.

Concluding Remarks by the Session Chairman: Co-chairs Phillip Spadaro and Norman Francingues expressed their deep appreciation to all for attending the session. Mr. Francingues thanked the speakers and the audience for their enthusiastic participation in the session. He also thanked the sponsors, WEDA, PIANC, and the Dredging Operations and Environmental Research Program for agreeing to organize and present this special session at the 21st Meeting of WEDA.

Mr. Francingues recognized the excellent afternoon of presentations by speakers who obviously knew their business and the topic of environmental dredging. Much of the discussion was about what environmental dredging was and was not and what it should or should not be. There were varying perspectives on what should be done in the future to get better at this topic of cleanup dredging. He concluded with the following personal observations about the session.

> "Environmental dredging can be defined as dredging that is done to reduce the overall environmental risks posed by contaminated sediments. It consists of a number of components or parts beginning with a crucial initial characterization of the sediment and concluding with the ultimate disposition of the dredged material. Each of the parts in the process is important and each has a cost and a risk assigned to it. The overall goal of an environmental dredging project should be minimization of both costs and risks.
>
> "The dredging industry obviously has demonstrated a significant capability to assist both the regulator and regulated to achieve high standards of environmental cleanup with dredging technologies. Significant advances have been made in both the precision and accuracy of dredges to the point of being almost as advanced as our ability to characterize and scope the environmental cleanup targets or end points. However, there is the recognition of the need to use highly skilled and properly trained operators if we are to implement environmental dredging technologies to achieve the project goals. This requirement should become part of the contract specifications bid package. In addition, we have learned about the advantages and disadvantages of incentive contracting to reduce the amount of material being dredged and disposed in confined disposal sites, but more innovation is needed in contracting for environmental dredging projects.

"Many challenges still lie ahead for the dredging industry. Some of these challenges are technology based while others involve developing improved confidence and better working relations with the cleanup authorities, problem owners, and the public. Working with organizations like PIANC and WEDA through sessions like we have experienced today can help us realize that dredging contractors will be able to respond to whatever the demands are of environmental dredging projects in the future."

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- **Speakers in order of presentations:**
  - Paul Doody, Blasland, Bouck, and Lee, Inc.
  - Ancil Taylor, Bean Environmental, Inc.
  - Bob Paulson, Wisconsin Department of Natural Resources
  - John Henningson, Hart Crowser, Inc.
  - Mike Crystal, Sevenson Environmental Services
  - Norman Francingues, U.S. Army Engineer Research and Development Center
- **Session organizers:**
  - Norman Francingues, Chairman, Publications Committee, U.S. Section, PIANC
  - Phillip Spadaro, Hart Crowser, Inc., Director of Ports and Harbor Services
- **The sponsors of the workshop include the following:**
  - U.S. Army Engineer Research and Development Center, Dredging Operations and Environmental Research Program
  - U.S. Section of PIANC
  - WEDA

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APPENDIX I
SESSION AGENDA

Wednesday, June 27, 2000, 1:30-4:30 PM

Session 5 – PIANC Session on Environmental Dredging

Chair – N. Francingues, U.S. Army Engineer Research & Development Center
Co-Chair – P. Spadaro, Hart Crowser, Inc.

Panel A - Environmental Dredging Projects

1:30-2:00 Dredging Effectiveness Defined - Paul Doody, Blasland, Bouck, and Lee, Inc.

2:00-2:30 New Bedford Dredging Demonstration - Ancil Taylor, Bean Environmental, Inc.

2:30-4:00 Fox River Environmental Dredging Project

- Regulator's Perspective - Bob Paulson, WIDNR

3:00-3:15 Coffee/Refreshment Break

- Design and QA - John Henningson, Hart Crowser
- Contractor Implementation - Mike Crystal, Sevenson Environmental Services

Panel B - Lessons Learned Panel

4:00-4:30 Facilitated Discussion on Environmental Dredging - All Panels Participants

- What we know
- What we don't know, and
- What we need to know

Appendix II
Presentations

The presentations are available in pdf format from the electronic version of this technical note.

- Defining the Effectiveness of Environmental Dredging
- Dredging for Environmental Remediation
- Fox River Environmental Dredging Project
  - Regulators Perspective
  - Design and Quality Assurance, The Design Engineer's Perspective
  - Contractor Implementation
- Environmental Dredging Components - How to Choose a Solution

Defining the Effectiveness of Environmental Dredging

Paul Doody, Blasland, Bouck, and Lee, Inc.

BBL

Defining the Effectiveness of Environmental Dredging

WEDA XXI
PIANC Session on Environmental Dredging
Houston, TX
June 27, 2001

J. Paul Doody, P.E.
Blasland, Bouck & Lee, Inc.

BBL

Overview

- Environmental vs. Navigational Dredging
- Sediment Risk 101
- Risk-Based Framework
- Effectiveness Parameters
- Experience from Completed Projects

2

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Navigational Dredging ⬇	Environmental Dredging ⬇
• Depth-based removal to deepen/maintain	• Risk-based removal (Concentration driven)
• Typically large volumes	• Higher environmental control
• High production rates	• Smaller volumes (lower production)
• Low cost	• High cost
• Disposal varies	• More restricted disposal

3

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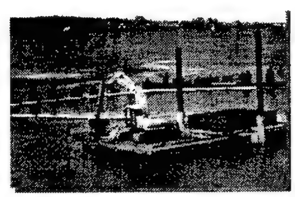
Dredging Effectiveness

Were the goals established at project inception accomplished?



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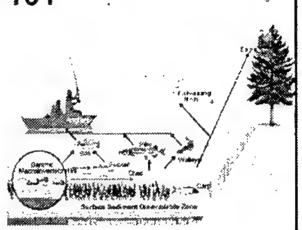
Sediment Risk 101

- Understand unique aquatic environment
- Risk related to:
  - Exposure pathways
  - Chemical concentration
    - *Fish/other biota*
    - *Water column*
  - Bioavailable sediment (i.e., surface sediment)
- Sediment stability is important



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Interpretation Of Dredging Effectiveness

- Definition
  - The degree to which contaminated sediment removal via dredging achieves acceptable reduction in risk to human health and the environment
- Concept
  - Should be evaluated in context of "Net Risk Reduction"
  - "Effectiveness" ≠ quantity of contaminated sediment removed at all sites
  - Need to evaluate on a site-specific basis
  - Need to incorporate sediment stability into interpretation

6

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Interpretation Of Dredging Effectiveness (cont'd)

- Potential Issues:
  - Risk reduction-based remediation goals should be established as a measurement of effectiveness
  - Actual reduction in risk is often not stated in measurable terms
  - Volume reduction/mass removal is often automatically equated with risk reduction
  - Empirical performance data on extent of risk reduction post-dredging (e.g., fish tissue reductions) are lacking
  - While short-term impacts are quantifiable, long-term benefits are not readily verifiable

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Effectiveness Parameters

- Important risk-reduction parameters
  - Fish tissue concentrations
  - Surface sediment concentrations
  - Water column concentrations
  - Air concentrations
  - Habitat quality
- Sediment stability
- Community concerns
- Schedule
- Cost/budget

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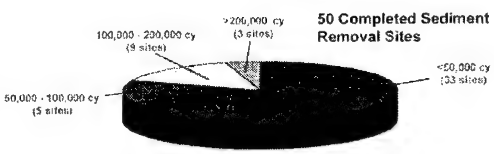
Completed Projects

50 Completed Sediment Removal Sites

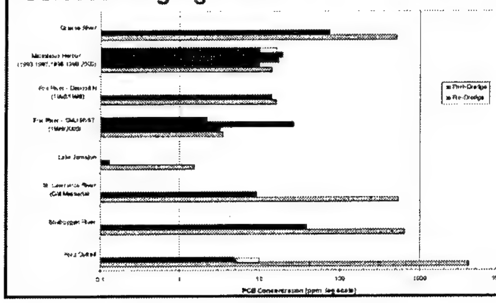


- Central repository:
  Major Contaminated Sediment Sites Database (Release 3.0) available at www.hudsonvoice.com
- Sites are relatively small
- Limited monitoring data
- Limited documentation

9

BBL

Average Surface Sediment PCB Data at Select Dredging Sites



10

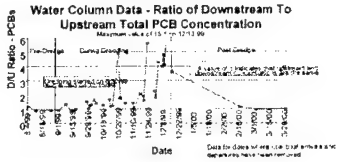
BBL

Water Column Data

- Limited long term data
- Most available data collected during dredging
- Available data indicate
  - TSS/turbidity controllable
  - Contaminant releases observed and bioavailable

Fox River, WI: SMU 56/57

Water Column Data - Ratio of Downstream To Upstream Total PCB Concentration



11

BBL

Biota Data

- Surprising paucity of data
- Complications with interpretation:
  - Ongoing natural recovery
  - Distinguishing from other remedial efforts
    - Source Control
    - Containment
  - Sampling location comparability
  - Impacts from remedy itself
- Habitat data practically non-existent

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BBL

Observations

- Most experience to date limited to relatively small sites
  - Limited available data
- Dredging has limitations in reducing surface layer contaminant concentrations
  - Some instances, capping necessary after dredging
- Resuspended solids can be controlled, however:
  - Elevated water column contaminant concentrations observed during dredging
- Effects of dredging on fish tissue concentrations not quantifiable
- Environmental dredging is distinctly different than navigational dredging

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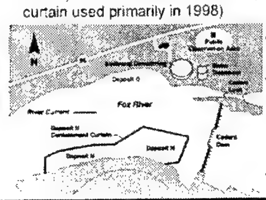
BBL

Fox River, WI – Deposit N

- 8,200 cy removed from November to December 1998 and August to November 1999 (WDNR) (1,000 cy removed from Deposit O)
- Removed via hydraulic dredging (cutterhead)
- Silt containment included a perimeter turbidity barrier (80 mil HDPE) and two deflection barriers (80 mil HDPE and a silt curtain used primarily in 1998)



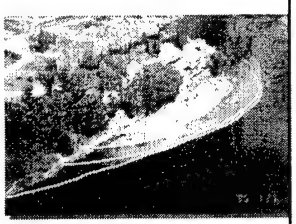
- Sediment dewatered and disposed off site
- Goal → Remove majority of contaminated sediment and leave thin residual layer (65% of volume targeted for removal due to bedrock conditions)
- Project cost = $4.3M ($525/cy)

14

BBL

Grasse River – Massena, NY

- 3,000 cy sediment and debris with PCBs removed in 1995 (Alcoa)
- Mechanical debris removal and hydraulic dredging (horizontal auger)
- Sediment dewatered and disposed on site
- Goal: Removal of "all" sediment
- Heavily studied/monitored program
- Performed as NTCRA
- Project cost = $4.9M ($1670/cy)



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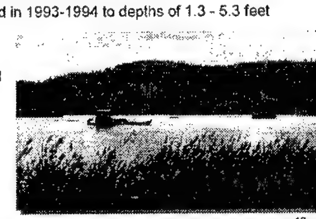
BBL

Lake Järnsjön, Sweden – Hydraulic Dredging

- 62-acre lake in Sweden located on the Emån River.
- Lake bottom was dredged in 1993-1994 to depths of 1.3 - 5.3 feet (196,000 cy)
- Goal → 0.5 ppm PCBs
- Sediment dewatered and disposed locally (upland adjacent to lake)

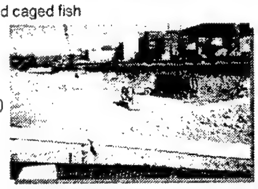


16

BBL

Ruck Pond – Cedar Creek, WI

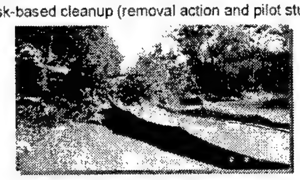
- 1994 removal of close to 100% of soft sediment (7,730 cy) from a temporarily drained 1,000-foot section of impounded creek (Mercury Marine)
- Goal → remove all PCB-containing soft sediment
- Heroic removal efforts employed
- Available data include sediment and caged fish
- Pre-removal surface sediment PCBs (0-6" or 0-24") = ND - 2,500 ppm (average = 56 ppm)
- Residual sediment exhibited 9.2 - 300 ppm PCBs (average = 76 ppm)
- Project cost = $7.5M ($970/cy)



BBL

Sheboygan River, WI

- 3,800 in-situ cy sediment with PCBs
- Discrete pockets
- Closed clamshell removal (11/89-11/91) (Tecumseh)
- Interim storage at Tecumseh facility
- Dermal risk-based cleanup (removal action and pilot study)



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BBL

Shiawassee River – Mechanical & Hydraulic Removal


Shiawassee River - Looking upstream from Bowen Road

- 1982 removal action (1,805 cy): selective sediment removal in 1.5-mile stretch below the plant site
- Removal ceased when funds ran out
- Since PCBs extended beyond 1.5 miles, 8 miles of river downstream of the plant site were subsequently declared a Superfund Site (1983)
- Increased PCB levels in caged fish were measured after the 1982 removal

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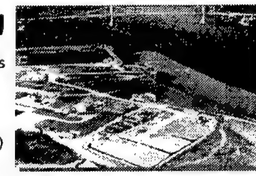
BBL

St. Lawrence River, GM Massena – Hydraulic Dredging



- 11-acre area of nearshore sediments dredged in 1995 (General Motors)
- Goal → 1 ppm PCB (sediment)
- Mechanical debris removal and hydraulic dredging (horizontal auger)
- Silt containment -- steel sheeting
- Removed 13,250 cy, stockpiled at the GM site in a lined and covered area and then disposed off-site in summer 1999
- Project cost = $11.5M ($870/cy)

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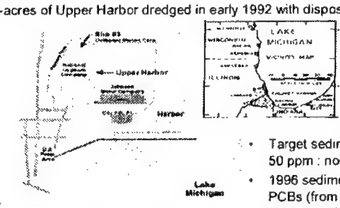
BBL

Waukegan Harbor – Hydraulic Dredging

- Slip #3 (max. 17,000 ppm PCBs) first remediated by dredging, then used as a CDF
- 10-acres of Upper Harbor dredged in early 1992 with disposal into the CDF



Waukegan Harbor

- Target sediment PCB cleanup 50 ppm : no PCB verification
- 1996 sediment data: 3 - 9 ppm PCBs (from 17 surface locations within the Upper Harbor)

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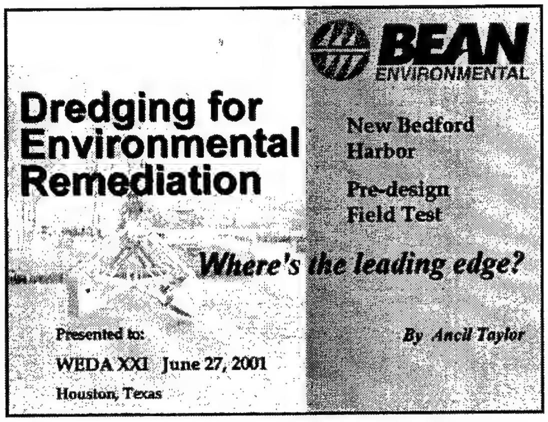
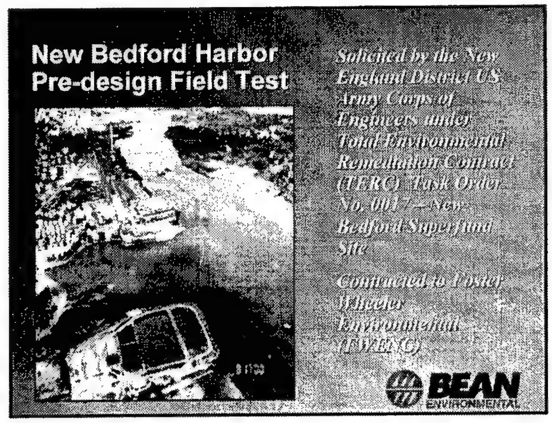
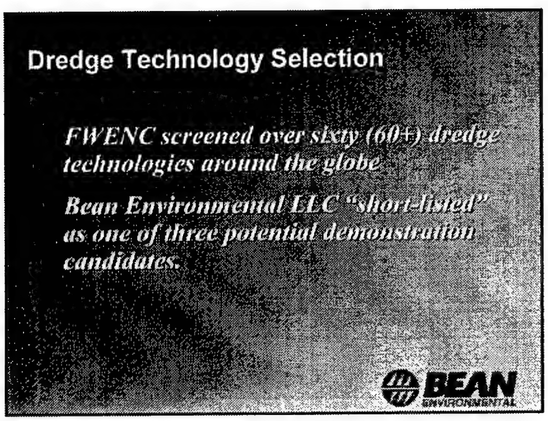
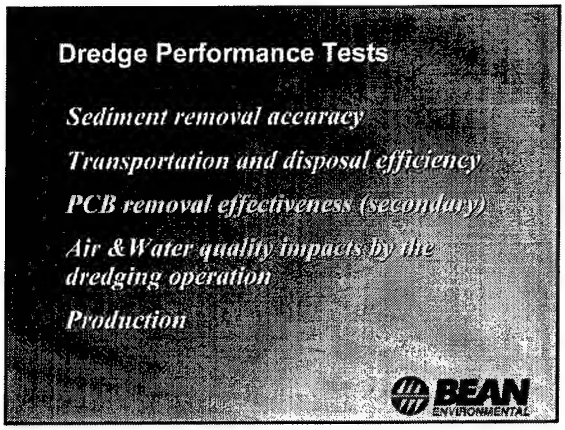
Dredging for Environmental Remediation

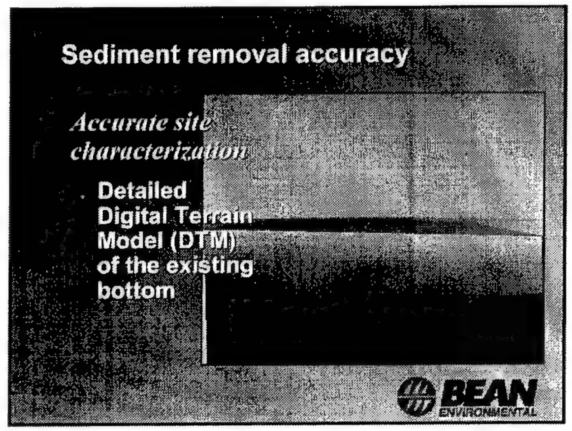
Ancil Taylor, Bean Environmental, Inc.

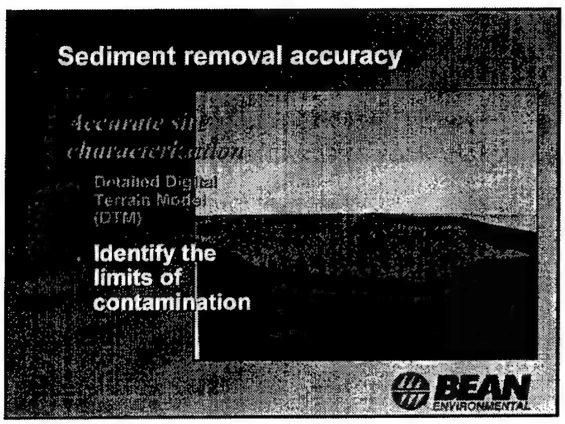


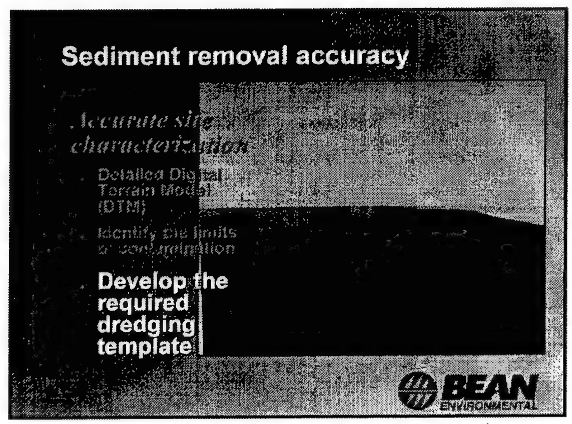


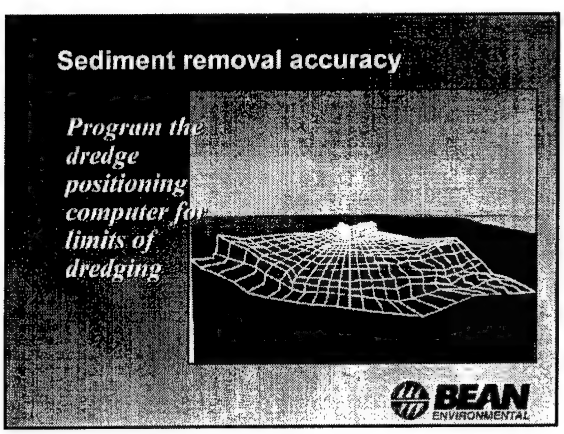


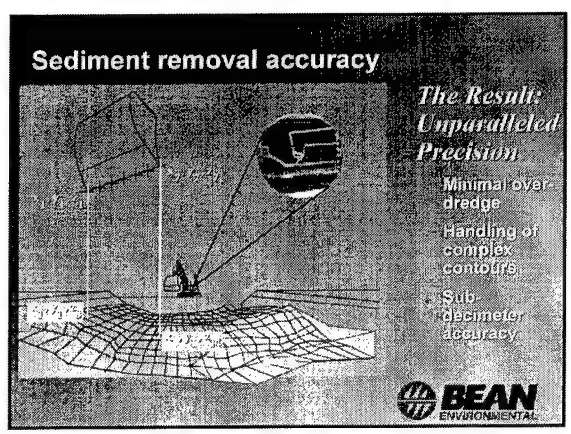

Dredge Performance Tests
Sediment removal accuracy
Transportation and disposal efficiency
PCB removal effectiveness (secondary)
Air & Water quality impacts by the dredging operation
Production
BEAN
ENVIRONMENTAL

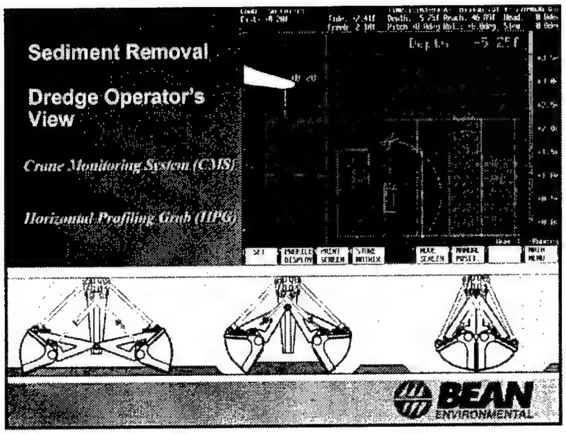

Sediment removal accuracy
Accurate site characterization
Detailed Digital Terrain Model (DTM) of the existing bottom
BEAN
ENVIRONMENTAL

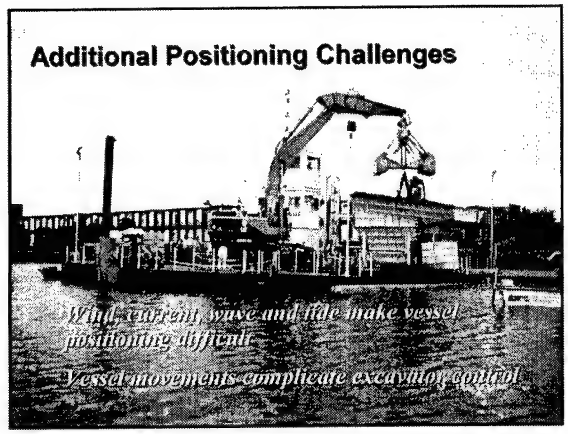

Sediment removal accuracy
Detailed Digital Terrain Model (DTM)
Identify the limits of contamination
BEAN
ENVIRONMENTAL


Sediment removal accuracy
Detailed Digital Terrain Model (DTM)
Develop the required dredging template
BEAN
ENVIRONMENTAL

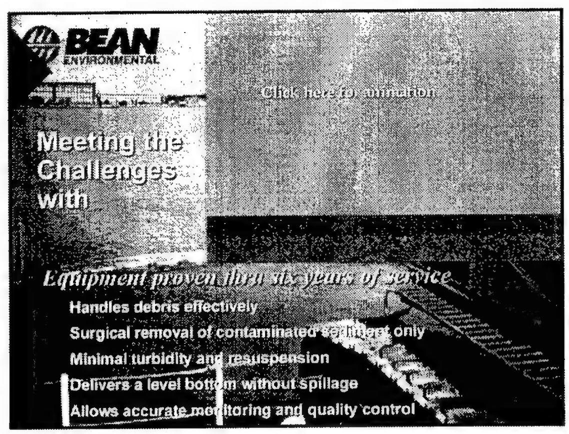

Sediment removal accuracy
Program the dredge positioning computer for limits of dredging
BEAN
ENVIRONMENTAL

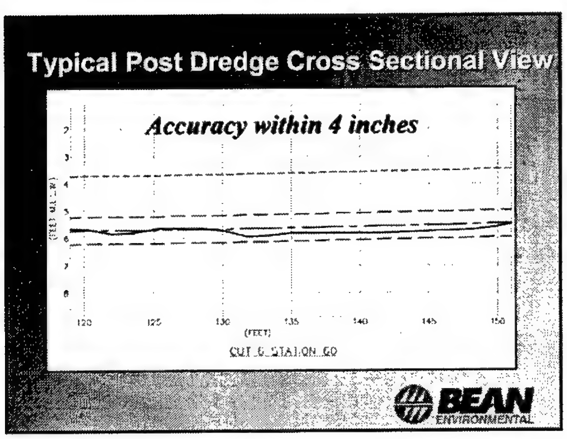

Sediment removal accuracy
The Result: Unparalleled Precision
Minimal over-dredge
Handling of complex contours
Sub-decimeter accuracy
BEAN
ENVIRONMENTAL

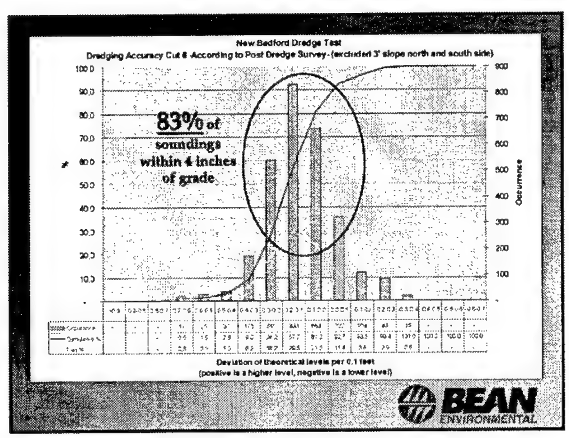

Sediment Removal
Dredge Operator's View
Crane Monitoring System (CMS)
Horizontal Profiling Grab (HPG)
BEAN ENVIRONMENTAL

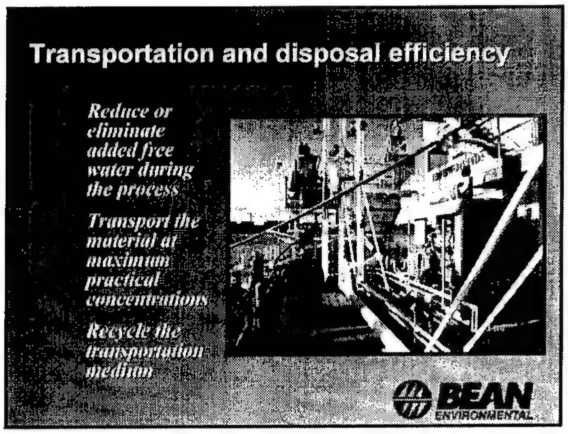

Additional Positioning Challenges
Wind, current, wave and tide make vessel positioning difficult
Vessel movements complicate excavation control

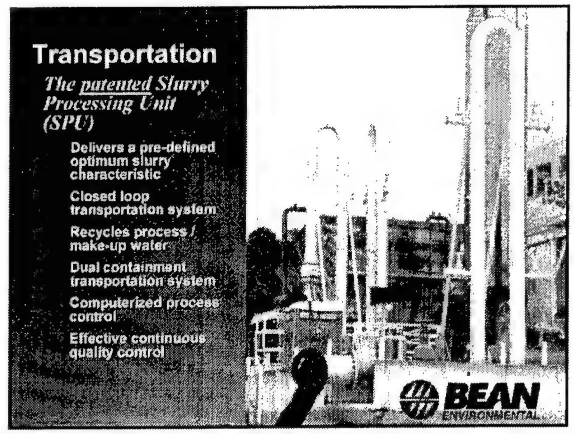

BEAN ENVIRONMENTAL
Meeting the Challenges with
Specifically designed equipment
Horizontal Profiling Grab (HPG)
Crane Monitoring System (CMS)
High speed integrated barge, crane, DGPS RTK positioning computers
(Patent Pending)

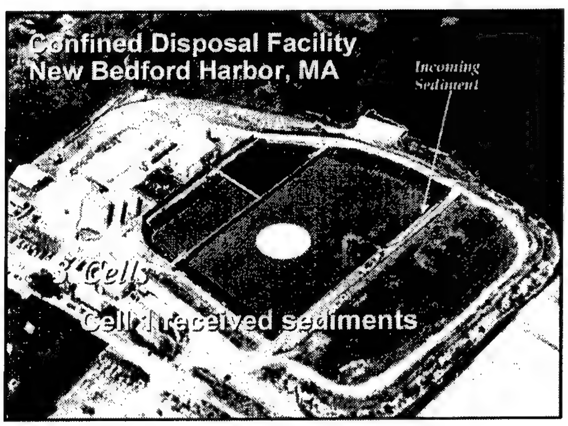

BEAN ENVIRONMENTAL
Click here for animation
Meeting the Challenges with
Equipment proven thru six years of service
Handles debris effectively
Surgical removal of contaminated sediment only
Minimal turbidity and resuspension
Delivers a level bottom without spillage
Allows accurate monitoring and quality control

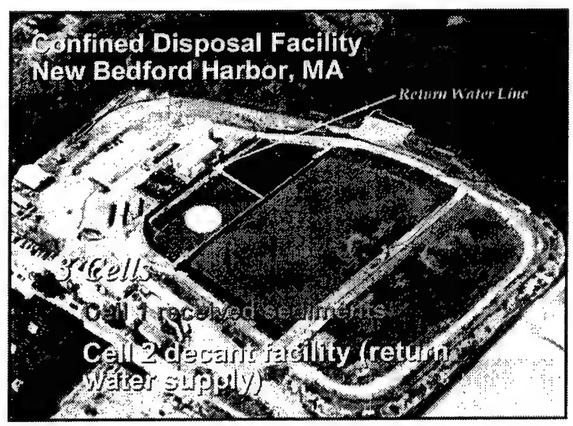

Typical Post Dredge Cross Sectional View
Accuracy within 4 inches
(FEET)
BEAN ENVIRONMENTAL

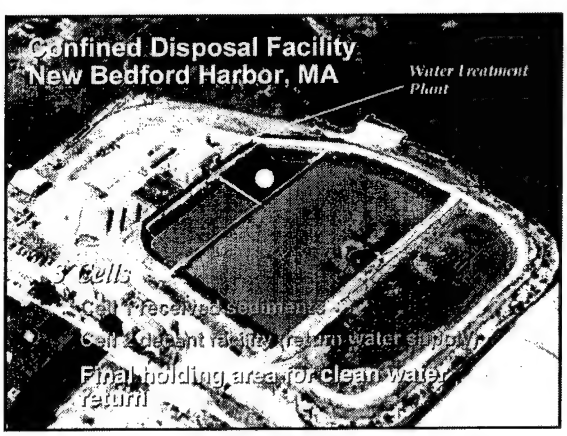

New Bedford Dredge Test
Dredging Accuracy Cut 6 According to Post Dredge Survey-(excluded 3' slope north and south side)
83% of soundings within 4 inches of grade
Occurrence
Deviation of theoretical levels per 0.1 feet
(positive is a higher level, negative is a lower level)
BEAN ENVIRONMENTAL

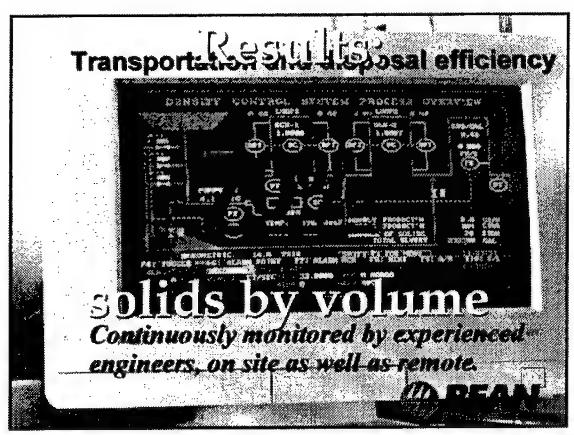

Transportation and disposal efficiency
Reduce or eliminate added free water during the process
Transport the material at maximum practical concentrations
Recycle the transportation medium
BEAN
ENVIRONMENTAL

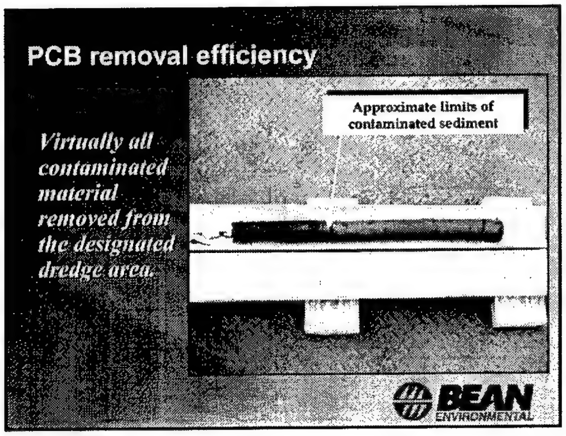

Transportation
The patented Slurry Processing Unit (SPU)
Delivers a pre-defined optimum slurry characteristic
Closed loop transportation system
Recycles process / make-up water
Dual containment transportation system
Computerized process control
Effective continuous quality control
BEAN
ENVIRONMENTAL

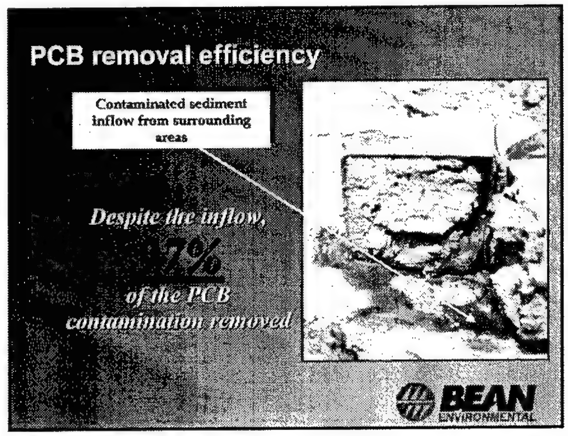

Confined Disposal Facility
New Bedford Harbor, MA
Incoming Sediment
3 Cells
Cell 1 received sediments

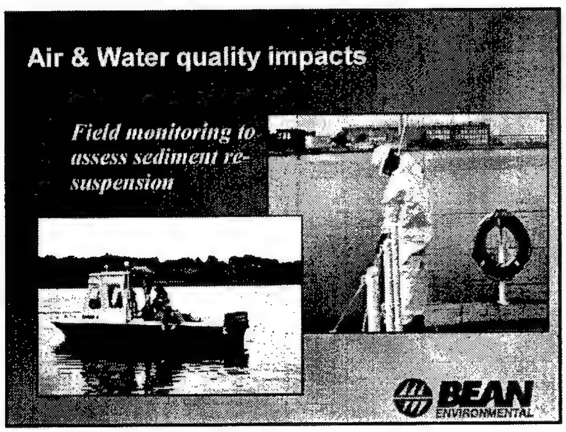

Confined Disposal Facility
New Bedford Harbor, MA
Return Water Line
3 Cells
Cell 1 received sediments
Cell 2 decant facility (return water supply)


Confined Disposal Facility
New Bedford Harbor, MA
Water Treatment Plant
3 Cells
Cell 1 received sediments
Cell 2 decant facility (return water supply)
Final holding area for clean water return

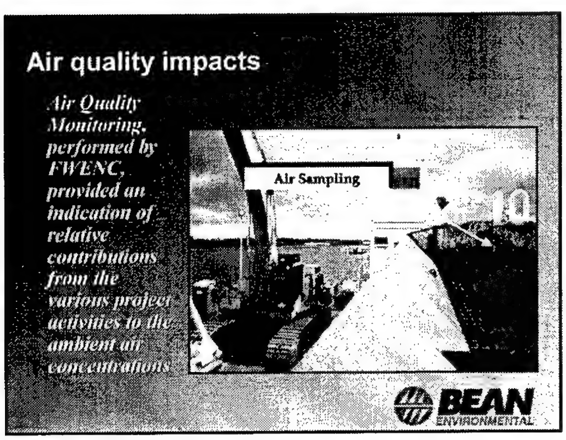

Results:
solids by volume
Continuously monitored by experienced engineers, on site as well as remote.

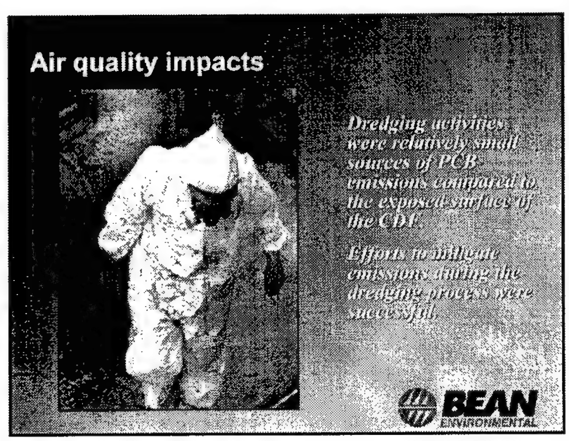

PCB removal efficiency
Virtually all contaminated material removed from the designated dredge area.
Approximate limits of contaminated sediment
BEAN
ENVIRONMENTAL

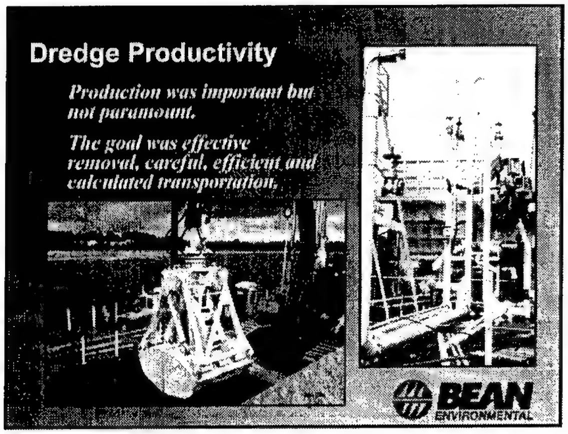

PCB removal efficiency
Contaminated sediment inflow from surrounding areas
Despite the inflow,
7%
of the PCB contamination removed
BEAN
ENVIRONMENTAL

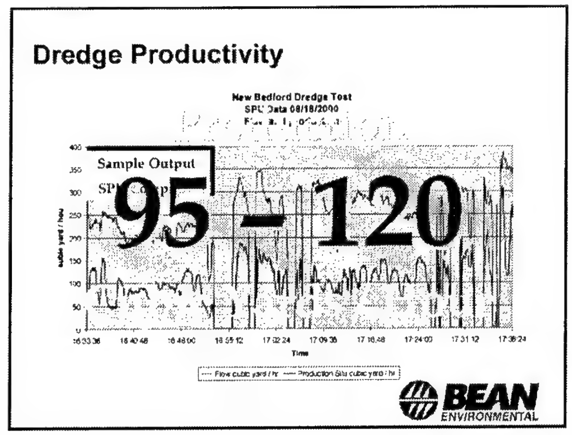

Air & Water quality impacts
Field monitoring to assess sediment re-suspension
BEAN
ENVIRONMENTAL

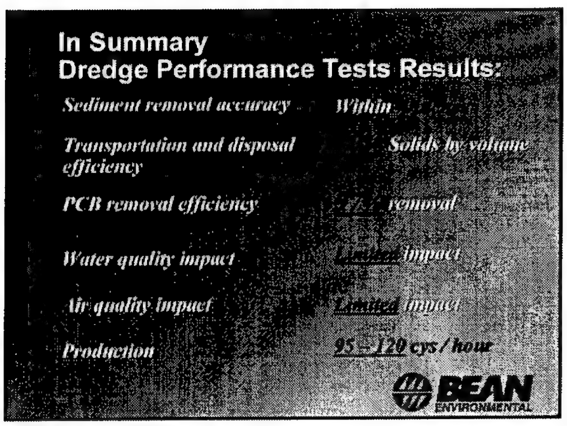

Water quality impacts
The actual dredging process resulted in a limited impact on the water column.
Support activities around the project had a greater impact on the water quality.
Ambient and local disturbances appear to have a similar or greater impact than the dredging operation.
BEAN
ENVIRONMENTAL

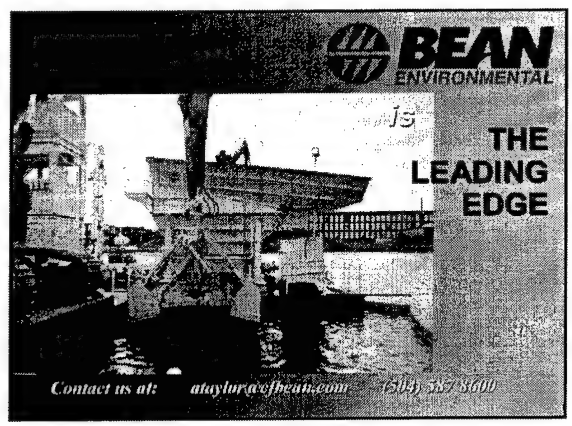

Air quality impacts
Air Quality Monitoring, performed by FWENC, provided an indication of relative contributions from the various project activities to the ambient air concentrations
Air Sampling
BEAN
ENVIRONMENTAL

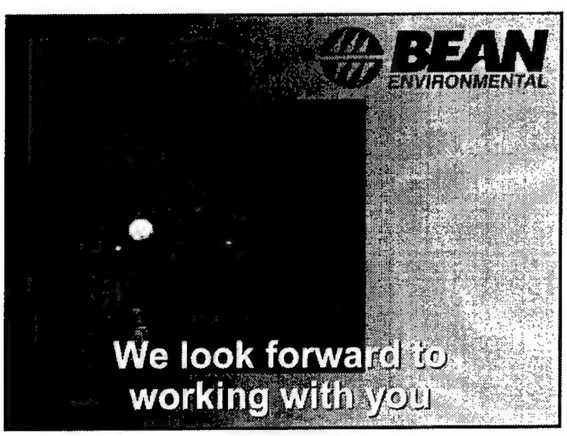

Air quality impacts
Dredging activities were relatively small sources of PCB emissions compared to the exposed surface of the CDF.
Efforts to mitigate emissions during the dredging process were successful.
BEAN
ENVIRONMENTAL


Dredge Productivity
Production was important but not paramount.
The goal was effective removal, careful, efficient and calculated transportation.
BEAN
ENVIRONMENTAL


Dredge Productivity
New Bedford Dredge Test
Sample Output
95 – 120
Time
BEAN
ENVIRONMENTAL

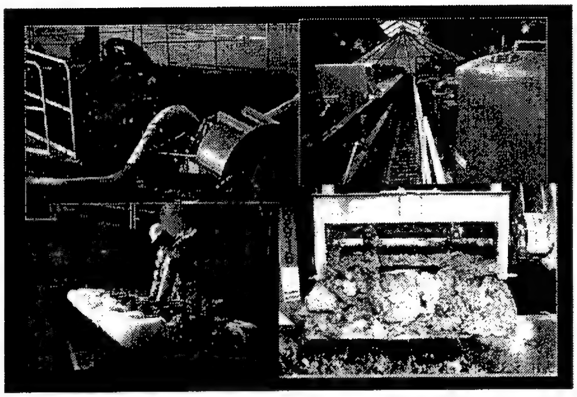

In Summary
Dredge Performance Tests Results:
Sediment removal accuracy
Within
Transportation and disposal efficiency
Solids by volume
PCB removal efficiency
removal
Water quality impact
Limited impact
Air quality impact
Limited impact
Production
95 – 120 cys / hour
BEAN
ENVIRONMENTAL


BEAN
ENVIRONMENTAL
is
THE
LEADING
EDGE
Contact us at:


BEAN
ENVIRONMENTAL
We look forward to working with you

Regulator's Perspective

Bob Paulson, WIDNR

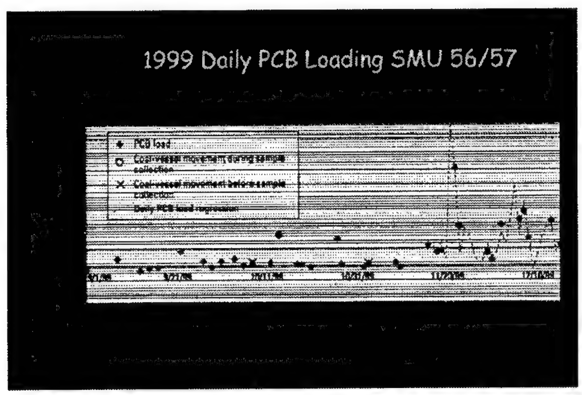


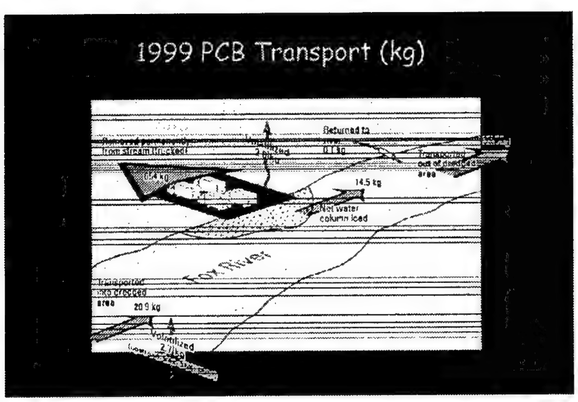
Implementation Issues

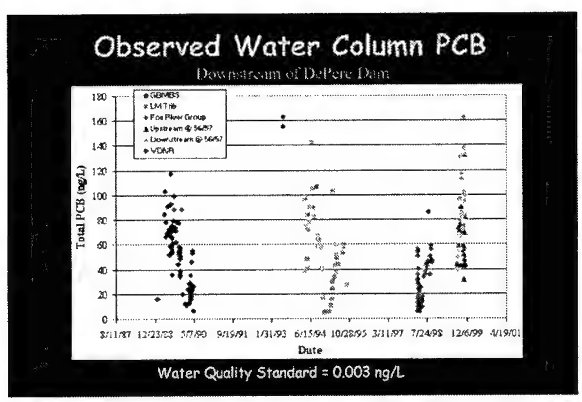
- Site specific cost information
  - ☑ ☑Effectiveness
- Permits/Net Environmental Benefit
- Show locals what activity would look like
  - Reverse NIMBYism
- Access agreements
  - Insurance(s)
  - Production shut down
- Contracts and subcontracts
- Liability Waivers/Indemnification
- Local Disposal

Pilot Dredging Monitoring

- Operational
- Effectiveness
  - Deposit Mass Balance
  - Process Mass Balance
  - River Transport
  - Air (@ SMU 56/57)
- > $ 2 million spent on environmental monitoring
- Reports available @ http://www.dnr.state.wi.us/org/water/wm/lowerfox/







Water Column

- Good day 1500x WQC
- Not so good day >50,000x WQC
- Concentrations during dredging no different than other observations
- 0.13 kg/d average daily loss during dredging vs 0.6 kg/d average daily river loading
- RAP STAC goal: losses < 10% of mass removed
- Deposit N and 56/57 downstream losses < 10%

24 hr Air Samples

10^{-5} Risk Level: 100 ng/m^3

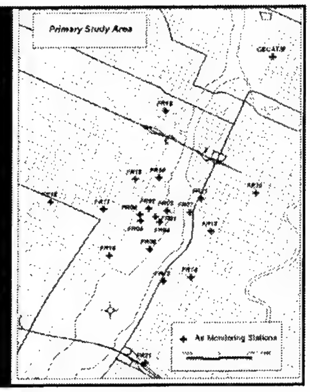
Before Dredging:
0.3 - 1.6 ng/m^3

During Dredging:

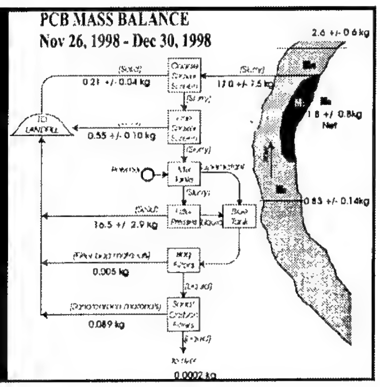
On Site: 0.7 - 80 ng/m^3

Off Site: < 0.2 - 3.6 ng/m^3

Flux: ~ 0.014 kg/day



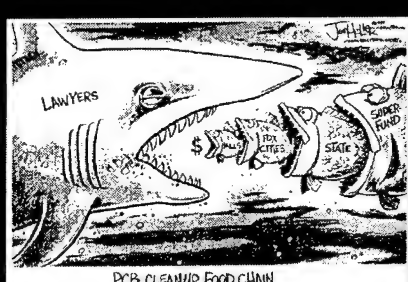
Deposit N



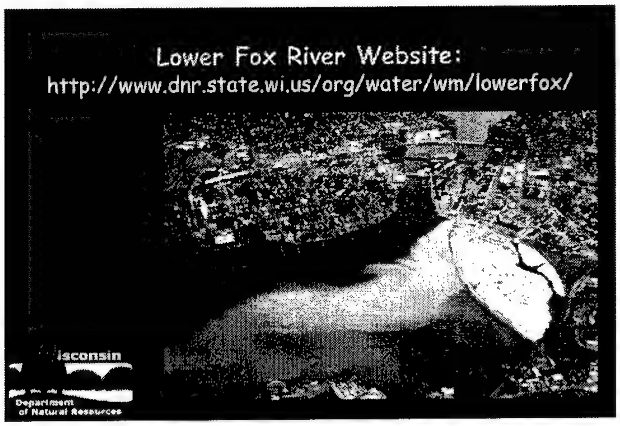
Pilot Dredging Lessons

- Showed Lower Fox River Valley that dredging was not "wide scale community disruption."
- PCBs permanently removed from river
  - 2000+ lbs at SMU 56/57
  - 112 lbs at Deposit N
- Disposal of sediments in local landfills
- Permit compliance
- Monitoring showed minimal losses
- Project objectives achieved

RISK REDUCTION ?

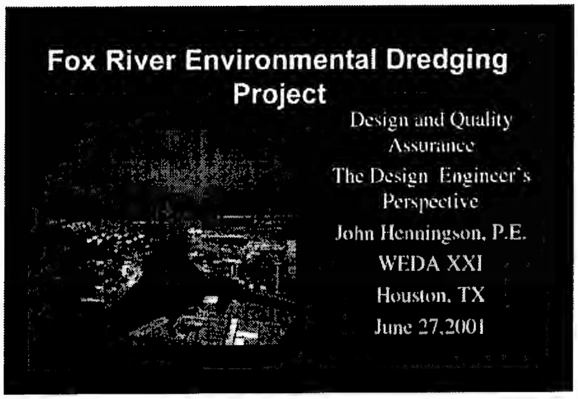


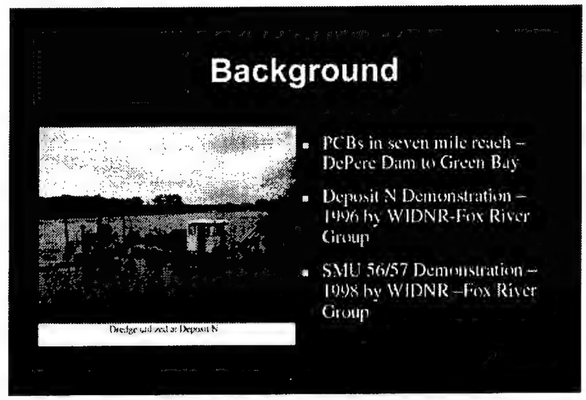
Glass Furnace Technology
Sediment Vitrification

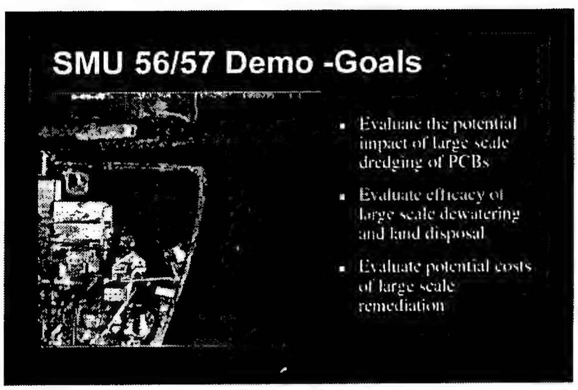

Lower Fox River Website:
http://www.dnr.state.wi.us/org/water/wm/lowerfox/
isconsin
Department
of Natural Resources

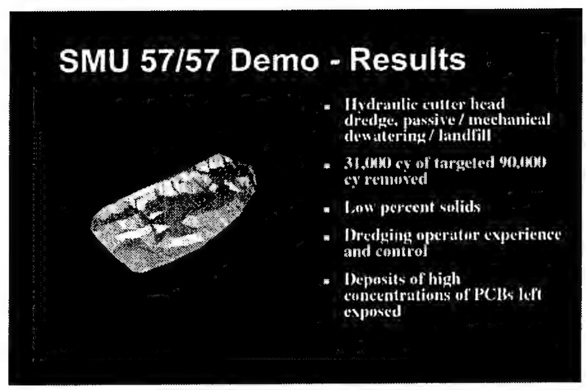
Design and Quality Assurance, The Design Engineer's Perspective

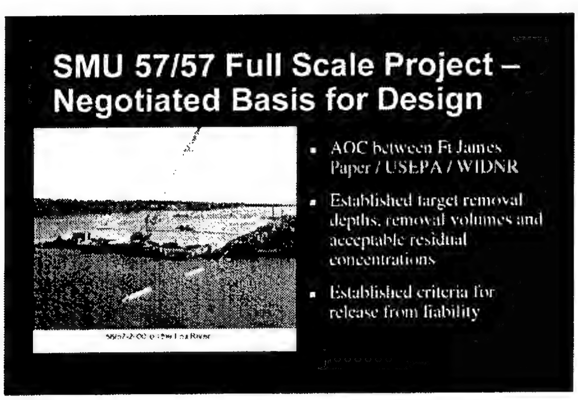
John Henningson, Hart Crowser

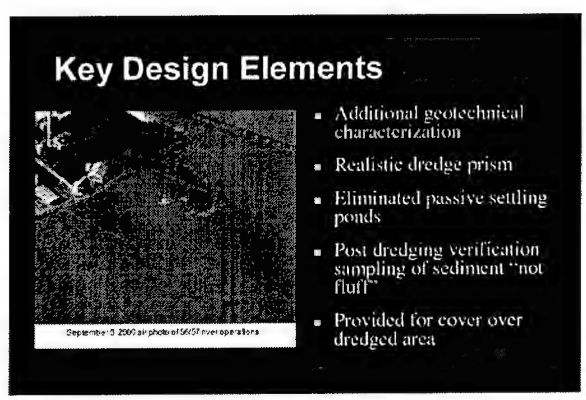


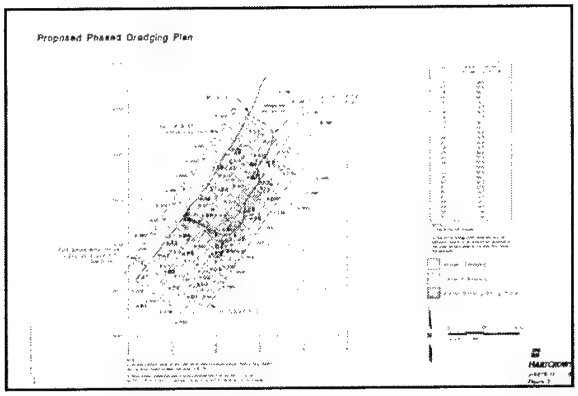


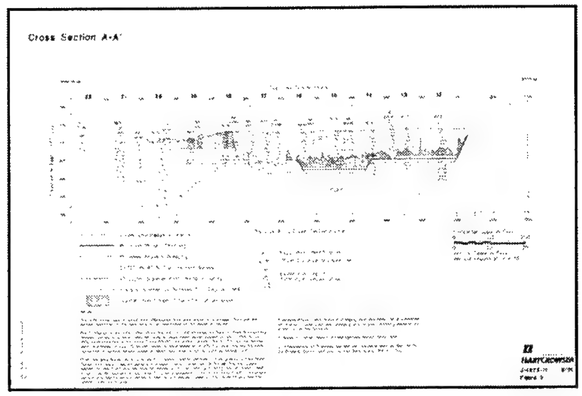


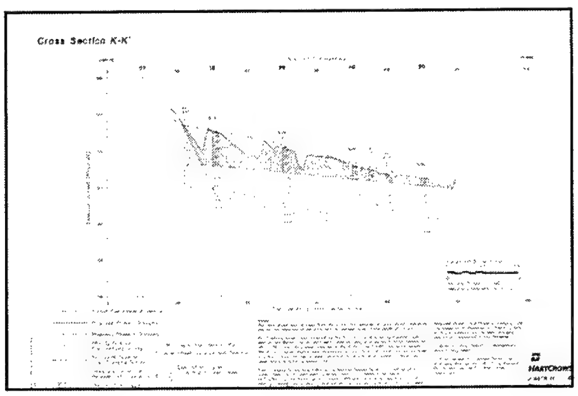


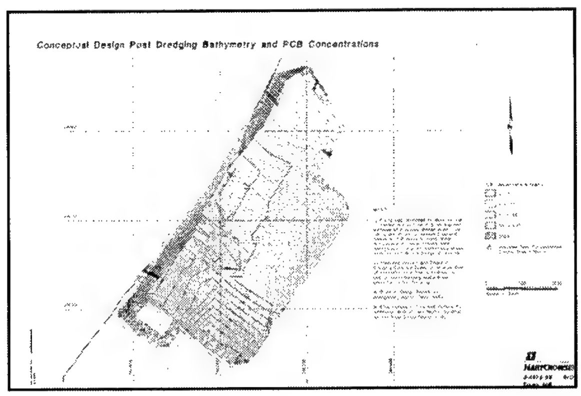


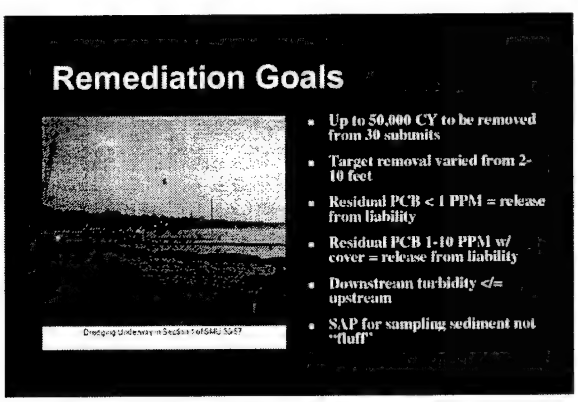


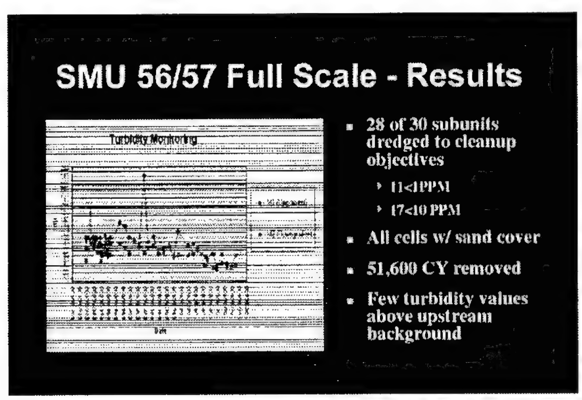

Proposed Phased Dredging Plan

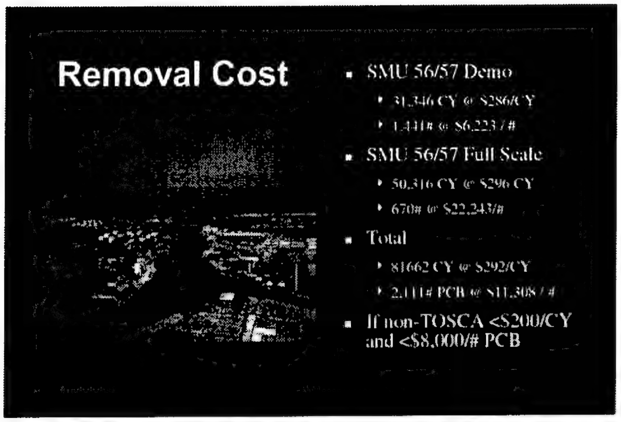

Cross Section A-A'

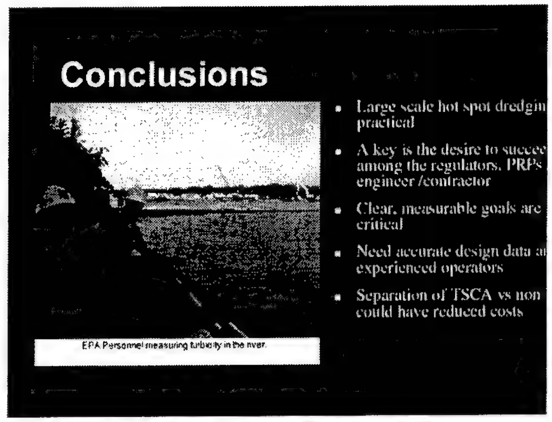

Cross Section K-K'

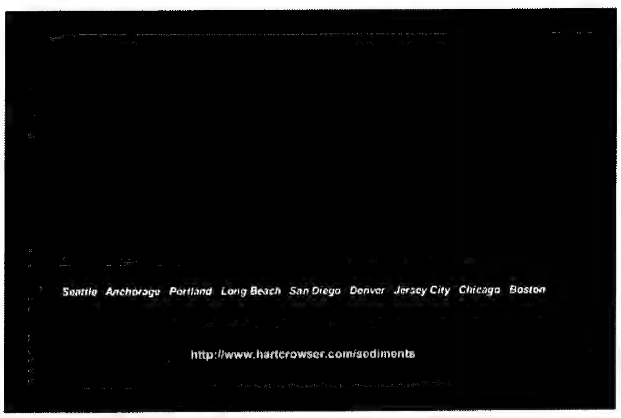

Conceptual Design Post Dredging Bathymetry and PCB Concentrations


Remediation Goals
Dredging Underway in Section 1 of SMU 56/57
Up to 50,000 CY to be removed from 30 subunits
Target removal varied from 2-10 feet
Residual PCB < 1 PPM = release from liability
Residual PCB 1-10 PPM w/ cover = release from liability
Downstream turbidity </= upstream
SAP for sampling sediment not "fluff"


SMU 56/57 Full Scale - Results
Turbidity Monitoring
Date
28 of 30 subunits dredged to cleanup objectives
11<1PPM
17<10 PPM
All cells w/ sand cover
51,600 CY removed
Few turbidity values above upstream background


Removal Cost
SMU 56/57 Demo
31,346 CY @ $286/CY
1,441# @ $6,223 / #
SMU 56/57 Full Scale
50,316 CY @ $296 CY
670# @ $22,243/#
Total
81662 CY @ $292/CY
2,111# PCB @ $11,308 / #
If non-TOSCA <$200/CY and <$8,000/# PCB


Conclusions
EPA Personnel measuring turbidity in the river.
Large scale hot spot dredgin practical
A key is the desire to succee among the regulators, PRPs engineer /contractor
Clear, measurable goals are critical
Need accurate design data a experienced operators
Separation of TSCA vs non could have reduced costs


Seattle Anchorage Portland Long Beach San Diego Denver Jersey City Chicago Boston
http://www.hartcrowser.com/sediments

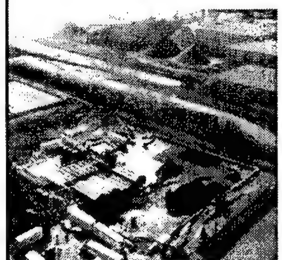
Contractor Implementation

Mike Crystal, Sevenson Environmental Services

FOX RIVER ENVIRONMENTAL DREDGING CONTRACTOR IMPLEMENTATION

Sevenson Environmental Services, Inc.

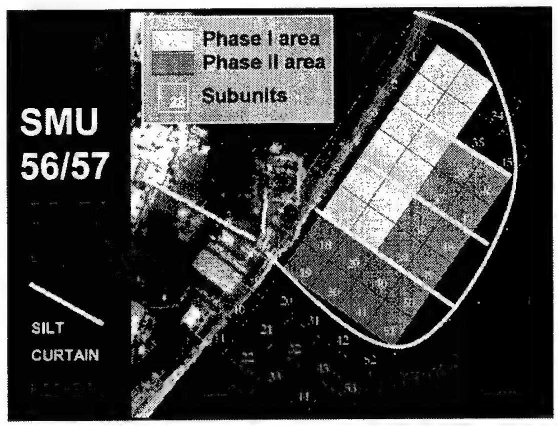
Fox River 2000 SMU 56/57 PCB Sediment Removal

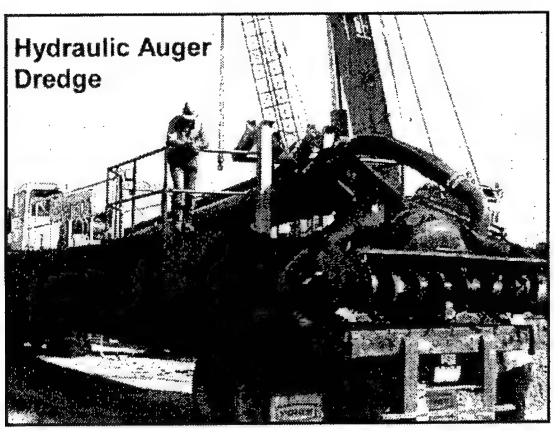


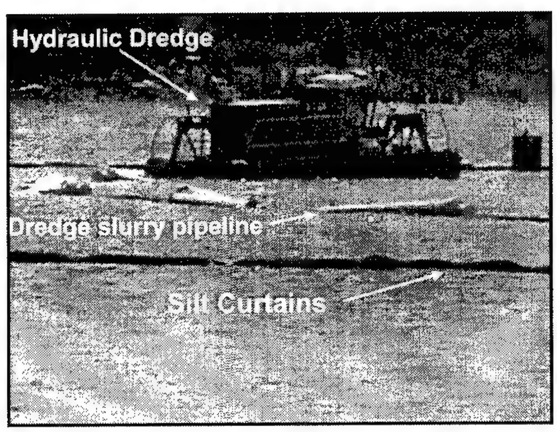
- Dredging & Dewatering 50,000 CY
- Fast Track / EPA Emergency Response
- Mobilization 25 Days
- 2400 gpm WWTP
- T&D @ Offsite Landfill
- Achieved All Project Goals & Objectives

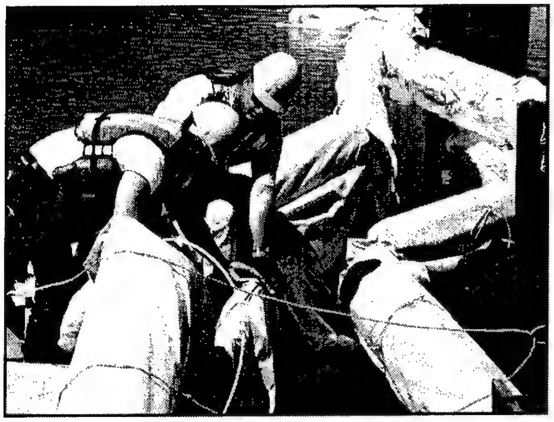
Project Goals

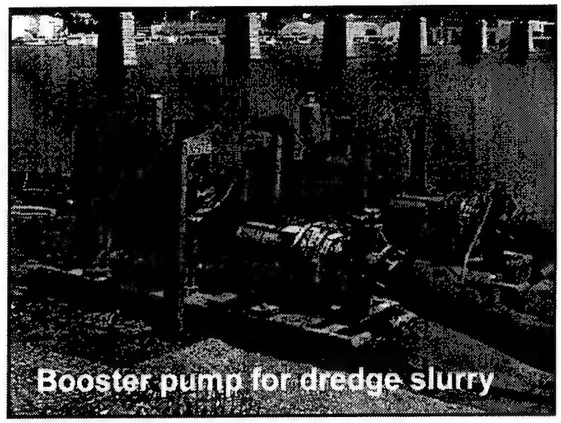
- Dredge to 1 ppm elevation
- Remove PCBs 10 ppm or more
- Cover with sand if concentrations more than 1 ppm
- Remove 50,000 cubic yards
- Complete project this year

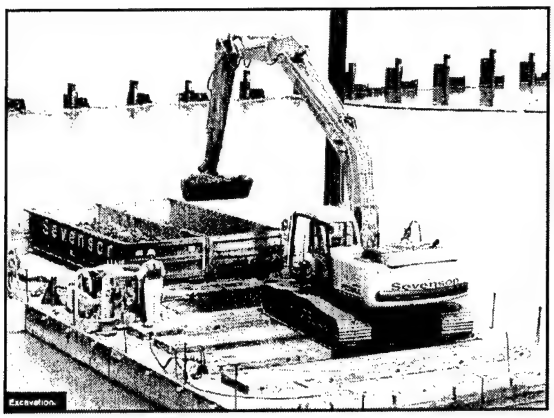






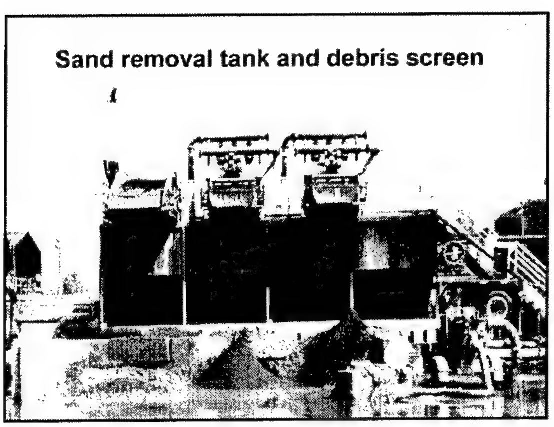


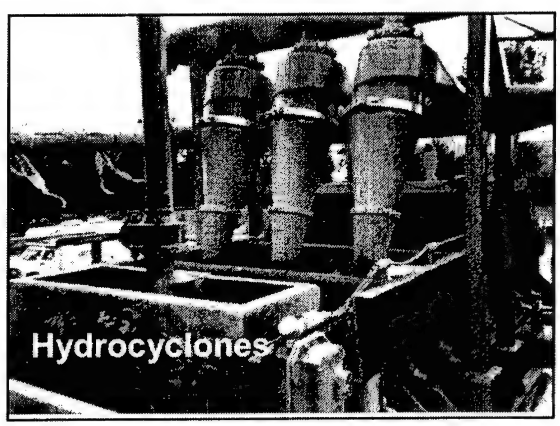


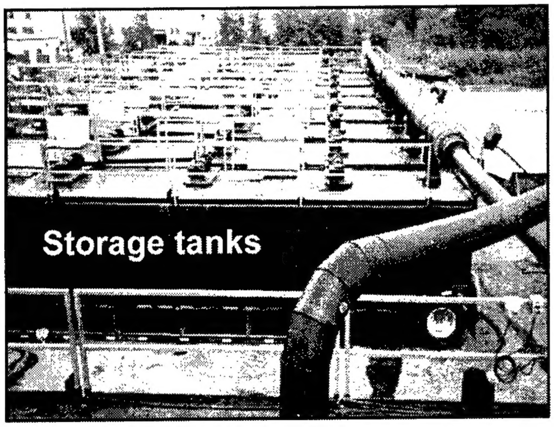


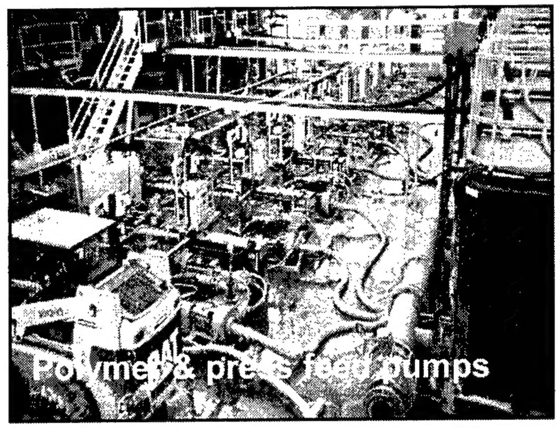
Dewatering

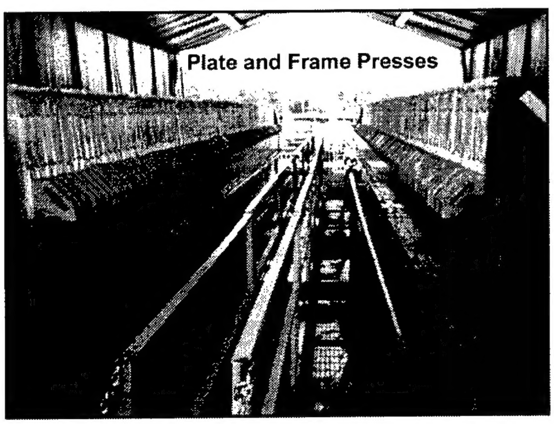
- Vibrating Shaker Screens
- Hydrocyclones
- Plate & Frame Filter Press
- Process Controls
- Treatability Study

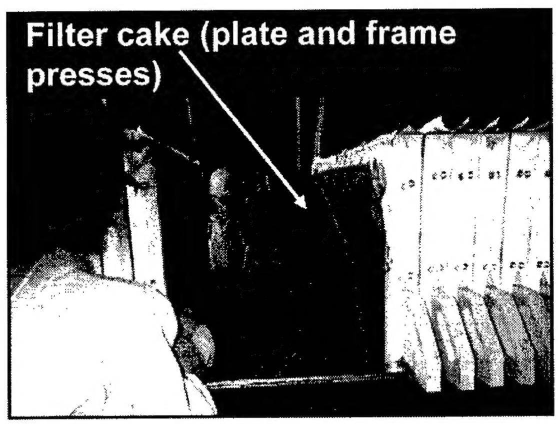






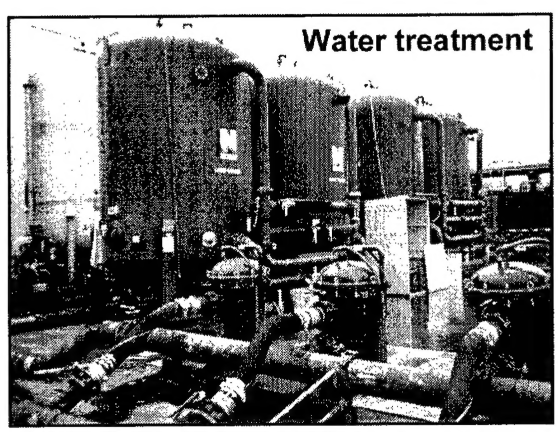






Wastewater Treatment & Material Handling

- Over Design Flow Capacity
- Redundancy in Process
- Continuous Wastewater Discharge
- Segregation of Processes
- Quick Analytical Testing

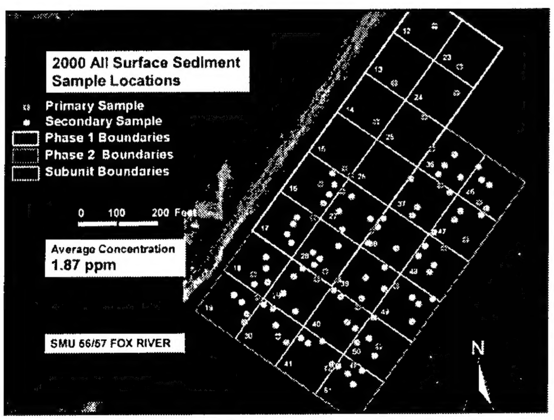


Critical Contractor Requirements for a Successful Project

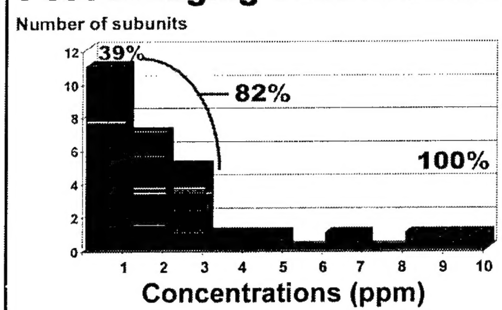
- Construction Background
- Environmental Dredging
- Dewatering (Liquid/Solids Separation)
- Wastewater Treatment
- Materials Handling
- Solidification & Stabilization
- Waste Minimization Experience
- Financial Security
- One Contractor: One Contract

Waste Minimization

- Maximize % Solids in Processed Material
- Screen over-sized Materials
- Separate Sand Fractions
- Decontaminate Debris
- Results in Significant Reduction of TSCA Waste



Post-Dredging Concentrations*



* Fort James data

Successful Project Summary

- Meeting All Goals & Objectives
- No Safety Infractions
- No Environmental Incidents
- Completion Ahead of Schedule
- Under Budget

EPA REGION V EMERGENCY RESPONSE TEAM

WISCONSIN DEPT. OF NATURAL RESOURCES

Sevenson Environmental Services, Inc.

FORT JAMES

Environmental Dredging Components – How to Choose a Solution

Norman Fancingues, ERDC

Session 5
Environmental Dredging

Panel B
Lessons Learned

Environment Dredging

How do you choose a solution?

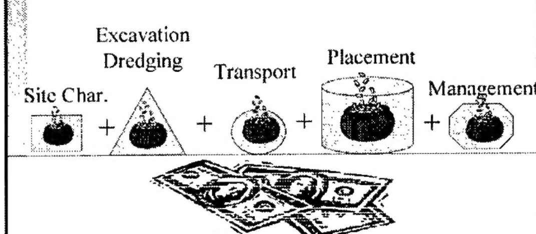
Answer:

You use a RISK-BASED approach

If you decide to dredge

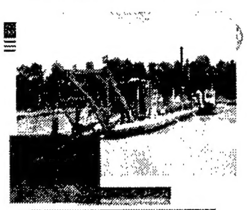
- **Risk doesn't go away**
- **Risk changes from one type to another**
- **Each step in dredging process has risk**
- **Hopefully, total risk is reduced**

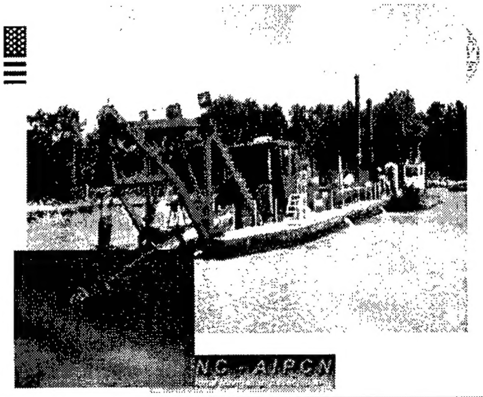
Risk Components of Environmental Dredging



Focus of Panel B

- On the **<u>Dredging Component</u>**





Lessons Learned

- What we know
- What we don't know
- What we need to know

Key Questions

- Should contracts be performance-based or tightly specified? Or, does this matter?
- Can the dredging industry meet strict excavation goals based on mass removal and/or residual concentration at the point of excavation?

Key Questions
(completed)

- Does dredge operator performance play a significant role in meeting performance criteria?
- If so, is special operator training required?
- What are the appropriate economic measures of environmental dredging?

Panel B - Summary

- The results of the session will be summarized in a paper to be prepared and published later in the WEDA *Journal of Dredging Engineering*.
- Acknowledgements - WEDA, PIANC, Presenters and Panel Members, and Participants